PUBLIC HEALTH 3.0

MARCH 22
2016

MEETING PROCEEDINGS:

PUBLIC HEALTH 3.0
Roundtable on Data, Metrics, and Predictive Modeling

U.S. Department of Health and Human Services

Hubert H. Humphrey Building

Washington, D.C.

Office of the Assistant Secretary for Health
U.S. Department of Health and Human Services

TABLE OF CONTENTS

EXECUTIVE SUMMARY 2

PREFACE 3

Public Health: Past, Present, and Future 4

How Can an Enhanced Data, Metrics, and Analytics Infrastructure Fuel the Transition into PH3.0? 6

Information Needs, Data, Metrics, and Analytics for PH3.0: Where Are We and Where Do We Go from Here? 8

Panel 1: Voices from the Field: Leveraging Data and Informatics Infrastructure 8

Panel 2: Frontiers in Big Data for Public Health 12

Panel 3: Innovations in Metrics and Predictive Modeling for PH3.0 Decision Making 15

Building Blocks for a Public Health 3.0 Informatics System: Meeting Top Challenges for Communities' Chief Health Strategists 18

Breakout Group A: Creating a Healthy Built Environment and Making Healthy Choices the Easy Choice 18

Breakout Group B: Supporting the Needs of Vulnerable Populations and Promoting Health Equity 20

Breakout Group C: Working with Businesses to Create a Healthy Workforce, a Vibrant Economy, and Thriving Communities 22

Reflections and Next Steps 23

KEY RECOMMENDATIONS 24

Appendix 1: Meeting Agenda 26

Appendix 2: List of Participants 28

Appendix 3: List of Resources 32

FURTHER READINGS 34

EXECUTIVE SUMMARY

On March 22, 2016, more than 40 thought leaders representing government, academia, and the private sector met in Washington, D.C. to discuss the future of public health. This roundtable was convened by the U.S. Department of Health and Human Services (HHS) Office of the Assistant Secretary for Health (OASH) and led by Acting Assistant Secretary for Health Dr. Karen DeSalvo. The full-day meeting focused on state and local health departments' data-related challenges and opportunities—and how the Federal government can help modernize public health. This topic is a critical part of Public Health 3.0, a new OASH initiative.

Public Health 3.0 aims to accelerate the upgrade of public health practice by emphasizing cross-sector environmental-, policy-, and systems-level actions to advance health equity and better address social determinants of health. Under Public Health 3.0, local health leaders act as chief health strategists to proactively enhance their community's health by coordinating across sectors. In the roundtable panels and breakout sessions, participants discussed strategies for modernizing the data and analytics infrastructure and making this new public health model a reality in every community across the country.

Roundtable participants identified current data-related challenges in public health—particularly issues in obtaining and linking existing data sets—and tools to make data actionable. Major challenges to obtaining usable data sets include technical and regulatory barriers, a lack of ZIP code–level data, and data disparities for vulnerable populations. Major data analysis challenges include a lack of interoperability across data systems, insufficient public health workforce capacity for developing predictive models and analytics display tools, and an outdated information technology infrastructure.

The group was unanimous that cross-sector partnerships can bolster local public health data efforts necessary for protecting the public's health during disasters and every day. Panelists also highlighted several innovative public health data initiatives across the country, which clearly show that this work is possible.

Roundtable participants developed an initial set of recommendations on how to move toward a Public Health 3.0 model that is locally relevant, accessible, and actionable:

- Invest in data linkage, data visualization, and non-proprietary predictive analytics that retain privacy and security standards without creating unnecessary barriers
- Adopt a national dashboard of metrics—such as the Institute of Medicine's Vital Signs—that displays community-level measures of health, including social determinants
- Interpret and analyze data at a local level in partnership with communities to effectively meet unique local needs, leverage assets, and enrich data with relevant context
- Leverage healthcare data and non-traditional data sources by cultivating partnerships with other government agencies and the private sector

Participants also suggested key questions to continue the data, metrics, and analytics discussion at 5 regional Public Health 3.0 meetings taking place in spring and summer 2016.

PREFACE

In late 2015, the U.S. Department of Health and Human Services (HHS) Office of the Assistant Secretary for Health launched the **Public Health 3.0** initiative under the leadership of Acting Assistant Secretary for Health Dr. Karen DeSalvo. This initiative aims to promote community health by markedly enhancing both the scope and capacity of public health practice, especially at the local health department level. Public Health 3.0 calls for local public health leaders to become "chief health strategists" in their communities by working with partners across multiple governmental agencies (such as housing, education, transportation, and city planning) and non-governmental sectors (including businesses, schools, non-profit entities, and faith-based organizations) to positively affect key social, environmental, and economic drivers of health.

The fundamental motivation of this initiative originates from the understanding that substantial progress in improving the health of Americans requires going beyond providing access to healthcare and preventive services. The evidence is clear that a large part of health and health behavior is driven by factors such as income, educational attainment, social cohesion, and other community characteristics (e.g., real or perceived safety of a given neighborhood). In fact, recent data shows that while individuals living with poverty generally live shorter lives across the U.S., the longevity gap between low- and high-income individuals is significantly narrowed in some communities that invest in fostering a health-promoting environment where healthy choice is the easy choice.[i] Armed with evidence on the importance of intervening upstream, the Public Health 3.0 initiative convened a series of regional meetings and leader roundtables to spark dialogues on the critical paths for all communities, small and large, to eliminate siloes and address pressing health challenges in multi-sectorial ways. Modernizing data, metrics, and analytics infrastructure is one of these critical paths of Public Health 3.0.

Public Health: Past, Present, and Future

The moniker Public Health 3.0 derives from a historical construct of public health practice in the modern age.

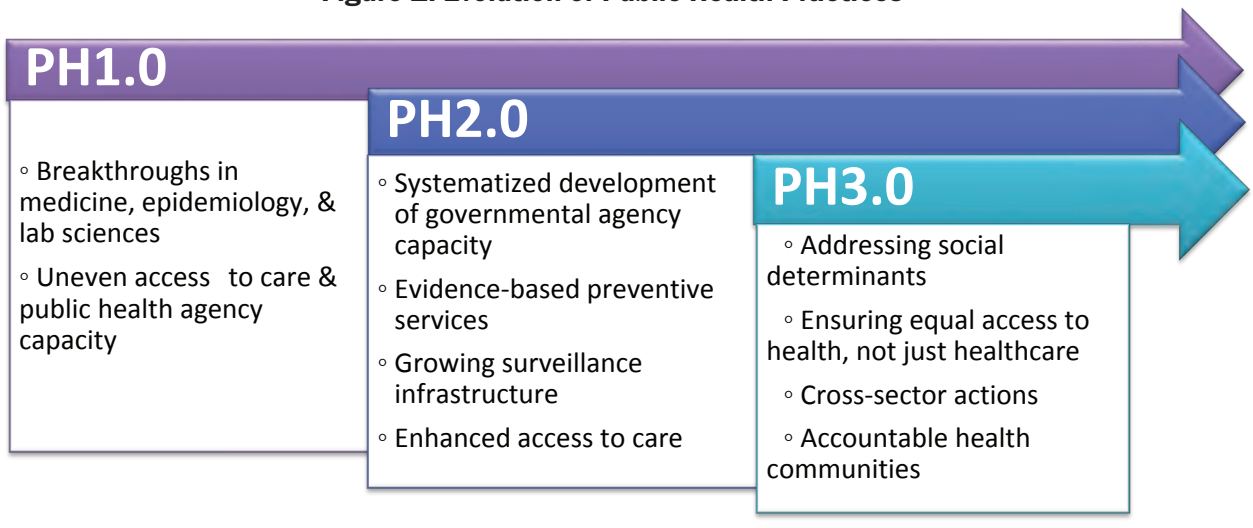
Public Health 1.0

The public health system, as we know it today, began taking shape in the late 19th and early 20th centuries. During this period, referred to as Public Health 1.0,[ii] public health primarily focused on preventing infectious diseases through clean food and water, disease surveillance, and, later, antimicrobials and vaccines. This era saw enormous advances in understanding disease causation and in the tools available for disease treatment and prevention.

Public Health 2.0

By the late 20th century, our environment was generally cleaner and safer, we had more effective medical care to treat disease and manage clinical risk factors, and—by and large—people were living longer and healthier lives. Yet, the progress was uneven throughout the country, and there existed great variability in the capacities of local public health departments to meet contemporary challenges like HIV/AIDS, the rise of non-communicable diseases, and preparing for natural or manmade disasters. In 1988, an Institute of Medicine (IOM)[iii] report, "The Future of Public Health," described a public health system in disarray,[iv] calling for comprehensive system reform. The IOM report launched a period of public health professionalization, culminating today in a voluntary movement to accredit state and local public health agencies according to clearly articulated capacities and practices. The period from the IOM report in 1988 until today is referred to as Public Health 2.0.

Figure 1. Evolution of Public Health Practices

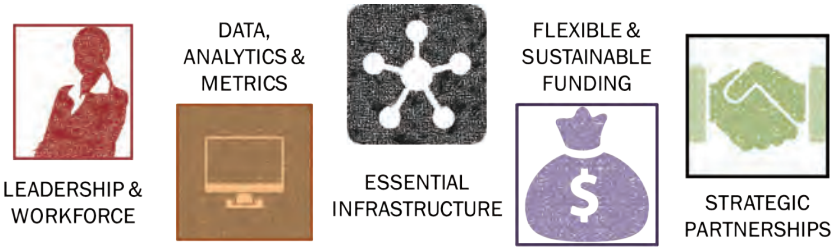


Public Health 3.0

Today, the leading causes of mortality and morbidity—cardiovascular diseases, diabetes, and cancer—are largely attributable to suboptimal behaviors as well as the social, economic, and physical environments in which people live, learn, work, and play. Public health practitioners face challenges from aging infrastructure and emerging infectious diseases, and must undertake strategic re-envisioning and adapt to meet these new challenges. Yet most health departments have not seen their budget or functional capacity fully restored since the Great Recession in the United States (2007–2009). The Affordable Care Act (ACA) eased some demand for public health's role in providing clinical care to the uninsured; it is also catalyzing a movement toward value-based payments, incentivizing innovative models for disease prevention and health promotion. The emergence of big data and novel data sources is also driving innovative practices on the front lines to measure and monitor community health.

In recognition of the need to address upstream social and environmental determinants of health, public health practitioners around the country are taking more collaborative and cross-sector approaches. It is in this context that DeSalvo et al. called for a collective envisioning of and broad transition to Public Health 3.0: a modern vision of public health practice. To enable local health departments to act as chief health strategists for the people they serve, 5 critical paths are identified: (1) strategic leadership and a skilled, multidisciplinary workforce; (2) data, metrics, and analytics tools to provide timely, granular, locally relevant, and actionable insights; (3) enhanced infrastructure designed to develop, support, and hold accountable Public Health 3.0 efforts while maintaining foundational capabilities; (4) more flexible and synergistic funding structures; and (5) broad yet strategic partnerships with the community, the business sector, and other key sectors.

Figure 2. Public Health 3.0 Themes



To better delineate both the challenges and the promising developments in data, metrics, and analytics, the Office of the Assistant Secretary for Health held the **Public Health 3.0 Roundtable on Data, Metrics, and Predictive Modeling** in Washington, D.C. on March 22, 2016. More than 40 thought leaders from a variety of settings—including hospitals, academic institutions, think tanks, professional and advocacy groups, foundations, health plans, and health technology and data management companies, as well as government agencies at the local, state, and federal levels—met to discuss the future of public health and what data, metrics, and analytics are needed to help local health leaders move toward the Public Health 3.0 era. This proceeding summarizes their discussions and insights.

How Can an Enhanced Data, Metrics, and Analytics Infrastructure Fuel the Transition into PH3.0?

In setting the stage, Dr. Karen DeSalvo, MD, MPH, MSc, Acting Assistant Secretary for Health and National Coordinator for Health Information Technology, described the 5 themes of PH3.0 and how many communities around the country are already pioneering the practice of public health in a cross-disciplinary and evidence-informed way. A key need in PH3.0 is an understanding of how federal public health agencies can support local public health—especially with regard to data, metrics, and analytics tools. Many local health departments currently rely on national data that are often several years old, were collected from labor-intensive surveys, and lack sufficient geographical granularity to be relevant to a local population. Moreover, even though state and county health departments may have obtained a wealth of data over the years, these datasets cannot be easily assessed, shared, or linked with other datasets that include critical information on the population. Dr. DeSalvo also pointed out that many local community leaders are exploring smart ways to leverage data in order to understand communities on a granular level, find new ways to access data in real time, and use non-traditional metrics (like civic engagement indices) to have data meet people where they are. Yet much of the progress remains patchwork and uncoordinated. One of the goals of PH3.0 is to develop a systematic way to capture, share, access, and use data at the local level.

Figure 3. Social Determinants of Health (SDOH)[v]

To illustrate her point, Dr. DeSalvo shared her previous experience as the Health Commissioner for the City of New Orleans in the aftermath of Hurricane Katrina. Tasked with rebuilding New Orleans' health system, it became apparent to her that she needed data to understand not only health status and healthcare in her city, but also social determinants of health such as local housing, education, and public safety. By and large, she said, these data were not accessible to a time- and resource-constrained health department like the one she directed. The lack of access to robust, reliable, and actionable data hinders the effectiveness of public health officials across the country. It became her mission to develop the data, metrics, and analytics necessary to transform public health in New Orleans and throughout the country. "This is just the beginning of a really important journey for this country," Dr. DeSalvo said, "making sure we have public health for all, and good data and analytics has to be one of the essential ingredients."

> "Caring about infant mortality is one thing," said a participant, "but public health is *responsible* for a community's infant mortality *rate*."

In response, participants noted the importance of leadership in modernizing public health informatics. Many echoed the IOM report[vi] in describing the tremendous capability disparities among health departments. Still, they also underscored several opportunities:

- The passage of the ACA has breathed new life into public health by reenergizing an appreciation for upstream change, placing a new emphasis on open data, and expanding health coverage. Success in coverage expansion has meant that healthcare is not only becoming more affordable, but potentially offering a better value.
- Delivery system reform incentivizes providers to explore their natural partners. As health systems move toward population health, it's important to recognize that public health is responsible for everyone who lives, learns, works, and plays in a community.

Information Needs, Data, Metrics, and Analytics for PH3.0: Where Are We and Where Do We Go from Here?

Panel 1: Voices from the Field: Leveraging Data and Informatics Infrastructure

What kinds of data and information do local public health leaders need to fully engage in cross-sector, PH3.0-style leadership, planning, and preventive interventions? How can we ensure that data is timely and sufficiently granular to guide resource allocation? What data, metrics, and analytics infrastructure (including training) needs to be developed and implemented to foster PH3.0 at the local health department level?

The first panel was convened to address these questions. It consisted of experts with past and current roles in leading or coordinating a local public health department. Sharing their perspective on the data needs, panelists addressed common challenges and gaps of current public health informatics infrastructure, as well as community-level indicators that are useful to address social determinants of health.

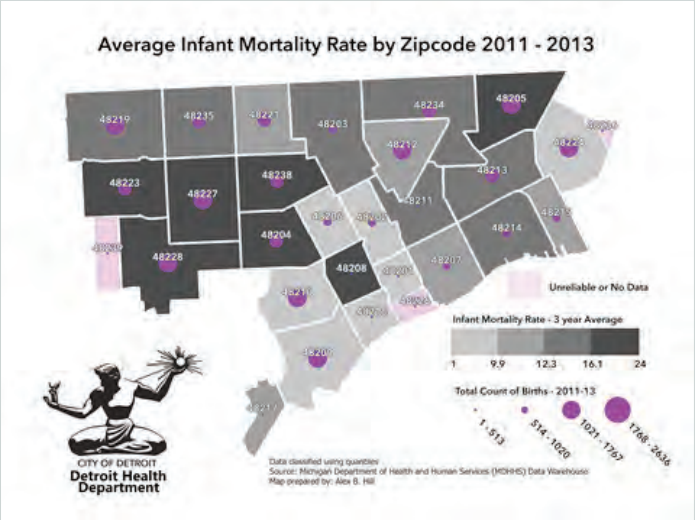
- **Dr. Joshua Sharfstein**, Professor at the Johns Hopkins Bloomberg School of Public Health and former State Health Secretary of Maryland, noted that public health officials need access to real-time data from a variety of sources. To be credible, public health must be able to sound the alarm on emerging issues and epidemics—before the media does.

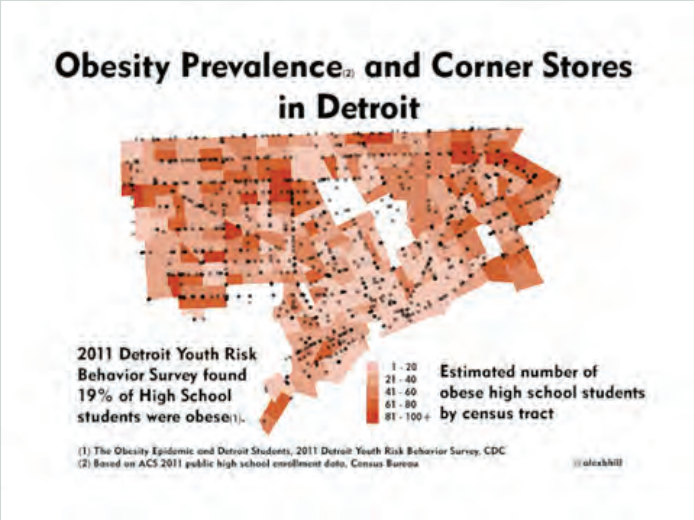
  While working on a healthy homes program in Baltimore, Dr. Sharfstein's team didn't have data on asthma rates in specific parts of the city. He received calls from press who knew about the local problems first. He believes that there is an opportunity to use healthcare data to illuminate such problems. Public health departments can map asthma admissions, environmental risk factors for asthma, known environmental violations, and other indicators. This can then be the basis for local interventions.

- **Dr. Paula Soper**, a trained health IT specialist representing the Association of State and Territorial Health Officials (ASTHO), recalled a similar anecdote. Reviewing county-level data, Dr. Soper noticed hot spots showing where children were being diagnosed with lead poisoning. It wasn't until she looked at housing data that she realized that the higher rates of lead poisoning were linked to properties owned by certain landlords. Dr. Soper noted that faster access to this data could have prevented cases of lead poisoning in children.

- **Dr. Abdul El-Sayed**, Public Health Officer for the City of Detroit, stressed that every locality has its own unique context. Knowing the whole story is essential to understanding a city's people and key issues—but it may not be immediately apparent in the traditional statistics. For instance, on the surface, Bronx, NYC, may appear very similar to Detroit, but in fact the experience of living, working, and playing in these 2 places is drastically different. Thus, he emphasized, it's important to make data digestible and visual whenever possible. Doing so through mapping can help contextualize and illuminate health issues.

Figure 4. Examples of Detroit Data Maps[vii]





- **Dr. Chris Aldridge**, of the National Association of City and County Health Officials (NACCHO), described a need for economic data, modeling, and forecasting to support decisions about healthcare investments. Dr. Aldridge described a pilot project with Econometrica, Inc. to develop support tools for public health officials. This could include, for example, modeling tools that visualize how investments in certain areas could impact immunization rates. Yet, he said, public health needs to bolster its expertise in economic modeling and forecasting—possibly through collaborating with academic institutions. Dr. Aldridge also emphasized that local health officials aren't only responsible for public health—they also act as the lead strategists for their communities.

Summary of Discussions

The group identified several types of data that are essential for Public Health 3.0 practices. Data also need to be available for smaller areas, such as at the state, county/commuting zone/city, ZIP code, and even neighborhood levels.

This is not intended to be an exhaustive list of essential data but rather is reflective of the mix of individual- and community-level data that might inform Public Health 3.0 efforts:

- School and employee absenteeism
- Housing and urban development
- Retail and consumer purchase patterns (e.g., Nielsen Consumer Panel)
- Physical environment characteristics that promote health (e.g., walkability, mixed-use, access to fresh food)
- Transportation environment, including access to cars and public transit

- Economic outcomes and business environment
- Civic engagement and social cohesion
- ZIP code–level trends for diagnoses in ERs, hospital admissions, and clinics
- Pre- and perinatal statistics
- Other data concerning unique problems and characteristics of the community

Participants also discussed bigger-picture issues affecting access to and usage of data:

- Lags in obtaining data and making data available for analysis
- Technical and regulatory (real and perceived) barriers to obtaining and sharing data, including misconceptions about HIPAA restrictions
- Lack of interoperability: data systems that don't connect to each other
- Differing reporting requirements that make it difficult to compare data across sources
- Complications with obtaining point-of-care data in a rapid, inexpensive, automated way
- Challenges in obtaining ZIP code–level data to have sufficient sample size and statistical power
- Gaps in the public health workforce, especially data scientists
- Paucity of tools and expertise to present data in a digestible, locally relevant, and user-friendly way, such as through maps, infographics, or interactive tools

The panel concluded with participants highlighting the importance of guidance, innovations, and cultural shifts in data sharing. Participants agreed that public health practitioners have a responsibility not only to collect data, but also to interpret it and use it to inform actions. Savvy data usage is not just about tracking what has already happened—it also has to inform what is going to happen next and what to do about it.

Are state, county, and local health departments required to comply with the HIPAA Privacy Rule?

Yes, if a state, county, or local health department performs functions that make it a covered entity, it must comply with the HIPAA Privacy Rule. For example, a state Medicaid program is a covered entity (i.e., a health plan) as defined in the Privacy Rule. Some health departments operate healthcare clinics and thus are healthcare providers. If these healthcare providers transmit health information electronically in connection with a transaction covered in the HIPAA Transactions Rule, they are covered entities.

However, the Privacy Rule expressly permits personal health information (PHI) to be shared for specified public health purposes. For example, covered entities may disclose PHI without authorization to a public health authority legally authorized to collect or receive the information for the purpose of preventing or controlling disease, injury, or disability [45 CFR § 164.512(b)], including but not limited to:

- Reporting disease, injury, or vital events (e.g., birth or death)
- Conducting public health surveillance, investigations, and interventions

PHI may also be disclosed without individual authorization to:

- Report child abuse or neglect to a public health or other government authority legally authorized to receive such reports
- A person who may have been exposed to a communicable disease or may be at risk for contracting or spreading a disease or condition, when legally authorized to notify the person as necessary to conduct a public health intervention or investigation
- An individual's employer, under certain circumstances as needed for the employer to meet the requirements of the Occupational Safety and Health Administration or similar laws

---

Source: Centers for Disease Control and Prevention. HIPAA Privacy Rule and Public Health: Guidance from CDC and the U.S. Department of Health and Human Services. MMWR [Internet]. 2003 Apr 11;52:1–12. Available from: http://www.cdc.gov/mmwr/preview/mmwrhtml/m2e411a1.htm

Panel 2: Frontiers in Big Data for Public Health

The second panel explored the following questions: How can public health officials harness the power of big data in addition to electronic health records and surveys in order to: better understand what creates health for the community and why; foresee emerging health threats; and shape how public health agencies can respond to present and coming challenges to promote health equity?

Several ongoing mapping and data-aggregation efforts were highlighted during the panel, as well as innovative uses of non-traditional sources of information.

- **Dr. Michael Painter**, of the Robert Wood Johnson Foundation (RWJF), described the work of his organization to build a "culture of health": making health a shared value, building cross-sector collaborations, making communities healthier and more equitable, and better integrating healthcare IT systems. Similarly, the 2014 JASON report "Data for Individual Health" describes creating a health information system that focus on the whole health of individuals, not just the care they receive.[viii]

  In 2014, the RWJF conducted a series of 5 listening sessions with community groups across the U.S. about using data to improve individual and community health. The findings are presented in *Data for Health: Learning What Works*.[ix] Finally, Dr. Painter discussed an upcoming collaboration among RWJF, CDC, and the CDC Foundation: the **500 Cities Project**. This project will be an updated version of RWJF's **County Health Rankings & Roadmaps**, providing census tract–level chronic disease data for the 500 largest cities in the U.S. The interactive website is slated to be released in 2017.

- **Peter Eckart**, Co-director of the RWJF-funded Data Across Sectors for Health (DASH) initiative, described DASH's focuses on data-sharing readiness. DASH currently has 10 grantees—5 projects led by local public health agencies to develop sophisticated shared data and analytics focused on population health improvement, and 5 multi-sector projects using shared data to address health disparities through improved care coordination with vulnerable populations. Mr. Eckart described how public health practitioners today are working in a rich environment for multi-sector data-sharing collaborations, as networks of projects like DASH join established local initiatives. The breadth and diversity of efforts across the country calls for innovative networks to share lessons and evidence-based best practices. One such effort is All In: Data for Community Health (All In), a virtual collaboration founded by DASH and AcademyHealth's Community Health Peer Learning Program. Through a shared learning collaboration, extensive networking, and a focus on national impact, All In is aligning the lessons from 25 local projects across the country. All In is one response to the need for new tools for knowledge management and ways to translate diverse experiences into actionable knowledge for the field.

- **Dr. Chris Fulcher**, of the University of Missouri Center for Applied Research on Environmental Systems, presented on Community Commons, a platform that overlays community-level data with national data. Community Commons was motivated by the wide availability, yet typically low accessibility, of secondary data. In addition to visualizing quantitative data, it is important to acquire qualitative insight behind the data points. "At the end of the day, people resonate with stories, not data," he said. To that end, Community Commons allows users not only to access data, but also to read stories embedded in the data.

Dr. Fulcher urged participants to continue considering data technology but not to lose sight of how data is being used:

> **"The light is shining on the data—by focusing on data-driven decisions alone, we may be missing the mark. It's more about people-driven decisions based on data."**

- **Dr. John Brownstein**, Chief Innovation Officer of Boston Children's Hospital and Harvard Medical School, presented the concept of the "digital phenotype"—the data footprint from an individual's daily life—and innovations to harness health information from non-traditional sources. His team's work, HealthMap, mines publicly available data from search engines, social media platforms, and wearable health technology to understand the health of populations. This technique has been applied to:
  - Surveillance, monitoring infectious or emerging diseases like Ebola
  - Patient experience and drug safety, gaining insight on unreported drug and vaccine side effects
  - Foodborne illness, identifying and tracking outbreaks using data from the review site Yelp

  Dr. Brownstein described how health technology can be useful for delivering public health interventions. In a project with Vaccine Finder and the ride-sharing service Uber, his group was able to deliver flu vaccines to 10,000 people in 4 hours.

  Often these data can be geotagged and time-stamped, offering useful real-time information to local public health officials. In essence, he said, using big data is "a way to translate the community's voice into a taxonomy that public health understands."

Summary of Discussions

- There is some similar work taking place among different groups to aggregate and map public data, and there is a need to systematize and coordinate these efforts.
- There are opportunities to standardize data formats. As of now, some records (for example, school absenteeism and food inspections) are still in written form and need to be digitized. Panelists recommended that funding agencies require grantees to make available raw, individual-level data, not just summary tables.
- Data alone may not resonate with users—when possible, it should be supplemented with digital storytelling and mapping tools.

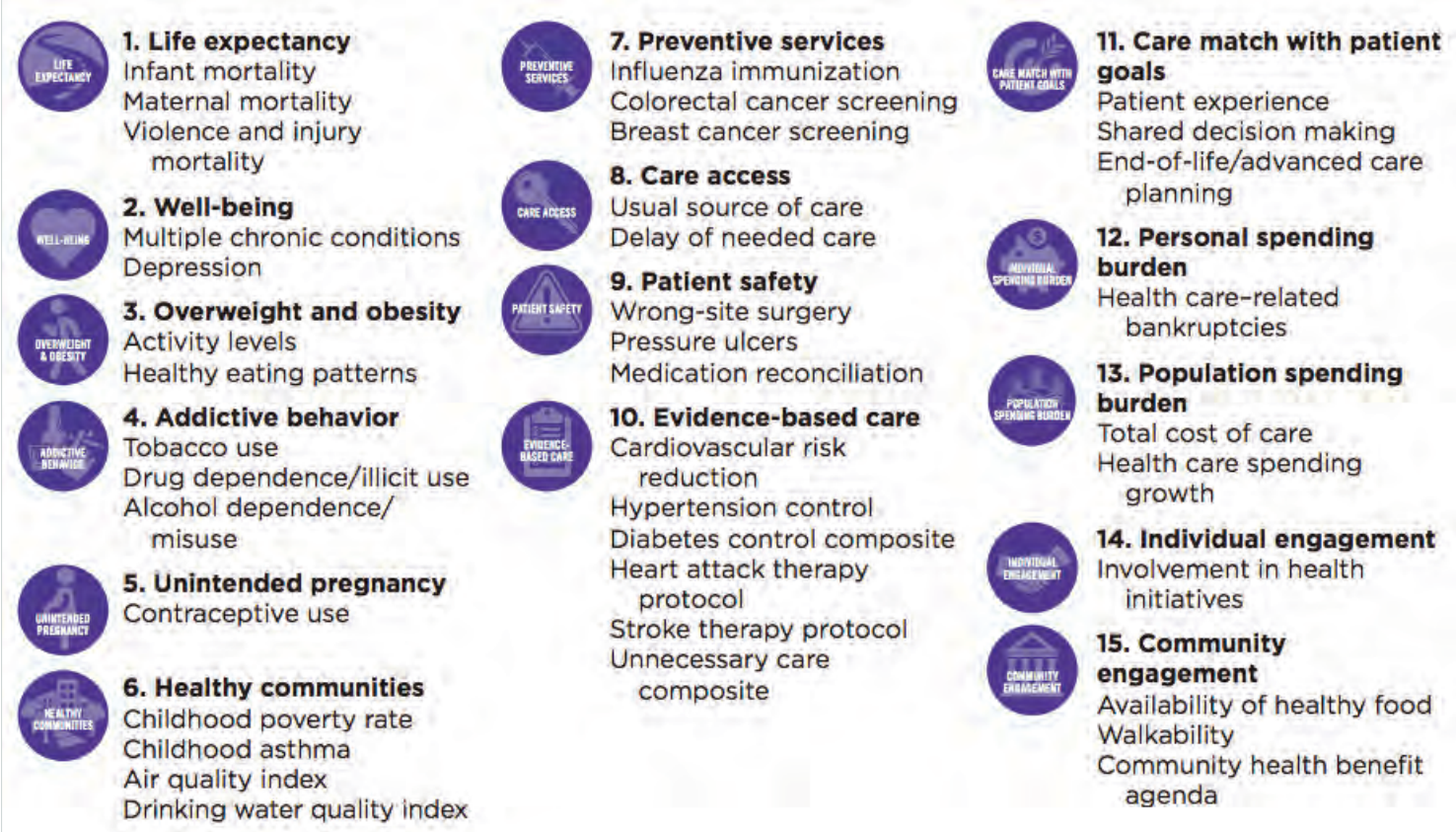
- Search engine and social media data can provide powerful, qualitative, consumer-generated data—and a way for public health to engage with communities. However, good analytic algorithms are essential in reducing the noise-to-signal ratio.
- Public health departments may not have the expertise or bandwidth to interpret the data to which they already have access, and would benefit from enhanced partnerships (e.g., with local universities or healthcare systems) and funding infrastructure. Some organizations might currently offer donations or assistance to public health, but the process needs to be systematized to be sustainable long term.

Panel 3: Innovations in Metrics and Predictive Modeling for PH3.0 Decision Making

While making data available, linkable, and accessible is important, possibly even more critical today is making sense of data to inform action and resource-allocation decisions. This panel explored the following questions: How can we use metrics to set benchmarks and track progress? What are the roles for—and essential features of—predictive and systems-based models in informing public health leaders about the likely health consequences and relative benefits of interventions targeted at various social determinants of health? What cutting-edge tools exist now that could help move PH3.0 forward?

- **Dr. Alina Baciu**, Program Officer at the Health and Medicine Division Board on Population Health and Public Health Practice at the Institute of Medicine/National Academy of Medicine (IOM/NAM), explained how in IOM/NAM's recent roundtable convenings, participants highlighted the need for transparency and good communication in modeling. Dr. Baciu noted the need to humanize models and explain why they're useful. Otherwise, people may be suspicious about their results. In terms of metrics, participants discussed barriers to measurement—such as in measuring community will, community engagement, resource investment, gentrification, health equity, or the role of youth and social media in gathering timely community data—and specific metric sets that include the social determinants of health.

Figure 5. Vital Signs Core Metrics for Health and Healthcare Progress[x]



- **Dr. Denise Koo**, from the Centers for Disease Control and Prevention, Office of the Associate Director for Policy, described the need for a universal menu of metrics that would serve as "vital signs" both to drive and to determine a community's level of health. This would be useful for policy work on the national level, but still flexible enough to address needs and priorities at the local level. A National Committee on Vital and Health Statistics (NCVHS) workshop in November 2015 reviewed a set of domains derived from the following 7 sets of indicators that cut across multiple sectors:
  - Healthy People 2020 Leading Health Indicators
  - National Prevention Strategy
  - America's Health Rankings
  - County Health Rankings and Roadmaps
  - CDC Community Health Status Indicators
  - The Vital Signs and Core Metrics for Health and Healthcare Progress
  - RWJF - Culture of Health

  NCVHS released a report after the meeting—in April 2016—which contains a thorough review of efforts that make use of sub-county-level data.[xi] This effort is intended both to highlight local needs and to support efforts to make data available in sufficient granularity for local action.

- **Rayid Ghani**, of the University of Chicago Center for Data Science and Public Policy, cautioned that the plethora of metrics may sometimes be counterproductive. Public health data often measure what is easy to measure rather than what is the best and most accurate predictor of health or disease. For example, healthcare and public health sectors typically do blood tests in children, then test the homes of children who test positive for lead poisoning. The majority of the homes end up having high lead levels—but we have failed at preventing lead poisoning. We could use this data to develop a predictive model for targeting home inspections. Mr. Ghani noted the need to build mathematical health equity into predictive models.

  It may also be recommended to educate computer scientists about public health issues so they can contribute to efforts to solve these problems.

- **Rebecca Niles**, of ReThink Health, described the ReThink Health Dynamics Model, an empirically based computer simulation that helps people plan how to strategically apply their resources for improvements in health. The model draws upon a robust, diverse set of data, including regional health and demographic data combined with metrics on effectiveness, cost, time frame, social determinants of health, payment reform, and financing. It calculates expected outcomes over a 25-year time horizon. Assumptions in the model are transparent and changeable—it's designed for healthcare leaders grappling with difficult resource allocation decisions. Users can play the model like a game; the best score suggests a small set of powerful policies and strategies. Providing an evidence base for decisions is key to demonstrating return on investment.

Summary of Discussions

- A strong focus on *purpose* is important—healthcare and public health sectors need to measure both the "what" and the "why."
- The Pew-MacArthur Results-First Initiative was mentioned as an example of robust, evidence-based modeling. The initiative works with states and localities to develop the tools policymakers need to identify and fund effective programs that yield high returns on investment.
- Although predictive models can be powerful decision-support tools, communication and transparency are key. Good models can help decision makers strategically deploy resources like time, funding, and staff.
- There are a lot of data but there's an enormous gap in analytics that are relevant to the local context.

Building Blocks for a Public Health 3.0 Informatics System: Meeting Top Challenges for Communities' Chief Health Strategists

Breakout Group A: Creating a Healthy Built Environment and Making Healthy Choices the Easy Choice

A Metrics Dashboard to Drive Health

Considering the many factors that make up a healthy built environment—housing, transportation, access to healthcare, clean water, nutritious food, and more—the group determined that having a simple, standard metrics "dashboard" could be helpful, especially one that includes social determinants data. Having a large amount of data available could promote flexibility—some communities will want different data, and a dashboard with extensive data would allow them to choose what is most relevant to them. However, there seems to be a tension between finding commonalities between communities and allowing for flexibility. The group stressed the importance of developing a menu of metrics from which to choose that would also still maintain national standards for metrics. Communities will engage more readily if they have a voice in which metrics are selected and have access to the specific data that would address the issues they are most concerned about. There are limitations in a broad approach because having too much data could mask the specific useful data that is needed. Some suggested it might be better to have a more targeted approach.

One way of capturing broad data could be for federal funders to require a core set of metrics to be collected on whatever participants are enrolled in a study. That would guarantee widespread data on a large population. This could be required of all federal grantees that are doing primary data collection.

Choosing Metrics

There was some debate over the approach to data collection; ultimately, the group decided that it is better to start by identifying key questions or health needs and then to target data collection accordingly. The group also considered data directionality—starting on the individual level and then aggregating versus beginning with regional data and then drilling down to a more granular level. The data needs differ depending on the question. For example, getting a general sense of a community might be possible with straightforward census data, such as poverty and median income. But, if diet quality is a particular concern, then using publicly accessible data might not be enough. There is some correlation between diet quality and availability of supermarkets, but not enough to feel comfortable inferring diet quality from that data alone. The group also recognized the limitations of community-level data and thus the need to aggregate individual data for these sorts of measures.

Participants recommended convening a group to identify actionable and available core measures. Example metrics could come from data on:

- Census and program eligibility/enrollment, such as poverty, income, and participation in the Supplemental Nutrition Assistance Program (SNAP) and the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC)
- Education, including absenteeism and high-school graduation rates
- Crime and incarceration rates
- Neighborhood walkability, such as determined by WalkScore
- Healthy eating and active living behavior patterns
- Transportation patterns (including bus, train, cars, bike share)
- GIS metadata

Existing models include:

- America's Health Rankings
- Healthy People 2020
- 500 Cities Project
- County Health Rankings & Roadmaps
- BlueCross BlueShield Association Community Health Management Hub

Participants noted that it would be important to organize these efforts in conjunction with other sectors, such as education and criminal justice. Too often, sectors speak different languages, and there needs to be some coordinating to allow for cross-sector work and for identifying patterns that are important to public health and other sectors.

Accessible and Actionable Data

The group recognized that identification of metrics and collection of data is valuable, but data should be available in a usable form for state and local health departments. Implementation of the dashboard also needs to include training for the users.

Breakout Group B: Supporting the Needs of Vulnerable Populations and Promoting Health Equity

The second breakout group discussed strategies and infrastructure needs for better addressing the needs of vulnerable populations. The group had a rich dialogue about better ways to collect data and link data systems. Specifically, while healthcare data can provide helpful information about the community's health, the most disadvantaged subgroups (such as homeless individuals) may not be represented in electronic health records. Participants acknowledged this "data disparity"—and discussed how to achieve a balanced portfolio of data.

Rethinking Data Collection Methods

Participants discussed the need for CDC to fund data collection that aligns with the PH3.0 model—and provide resources to state and local health departments to meet those standards. Currently, CDC uses different methods to conduct disease surveillance and collect data on each health condition, and it's difficult to link or compare them. They recognized the need for better integration of CDC data collection, but also noted that there may be some data that CDC no longer needs to collect because state and local health departments are able to gather it from electronic health records in a cross-cutting and systematic way.

Using Data to Pinpoint Issues and Communities to Connect the Dots

Each community best understands its own unique characteristics and problems. With an eye toward health equity, participants discussed that decisions about data collection will be made at the national level, but qualitative analysis to understand the data should be done in partnership with communities. Community engagement could include building public/private partnerships with community-based organizations. The group also discussed, as was mentioned earlier in the meeting, that public health efforts are led by a community's chief health strategist, but it would be valuable to establish a community coalition to decide which data are needed and how to interpret them.

Building Infrastructure to Support Health Equity

Participants considered the infrastructure needed to engage communities, build trust, and increase awareness of disparities. One key element in this conversation was basic IT infrastructure; many state and local health departments lack adequate hardware and software to accommodate PH3.0 data standards. A second major factor is that data systems don't link to each other. Currently, it's difficult to link health and social services data—and to share data between sectors. Many datasets concerning health, housing, and income data have privacy protections that often prevent sharing or linking. Furthermore, the Federal government needs to clearly articulate privacy standards, because states may interpret these rules differently.

Drawing from Innovative Examples

Participants cited several examples of organizations and federal agencies that have been successful in linking and sharing data systems:

- CDC has made great progress in tracking healthcare-associated infections through the use of electronic health records.
- The Office of the Assistant Secretary for Preparedness and Response developed GEOHealth and EmPower tools, which give local health departments access to Centers for Medicare and Medicaid Services data about vulnerable populations, such as those dependent on electrical healthcare equipment, to locate and help them in the event of a disaster.
- ASTHO, NACCHO, the Council of State and Territorial Epidemiologists, and the Association of Public Health Laboratories have been working on a common cloud-based platform for data exchange.
- The University of Massachusetts Lowell's Institute for Visualization and Perception Research has developed the open-source Weave tool to allow users to display their own data using a variety of linked interactive visualization tools, allowing more user-friendly information sharing while protecting privacy.

In spite of these developments, much remains to be done to coordinate and systematize data collection, analysis, and dispersal to best serve vulnerable populations.

Breakout Group C: Working with Businesses to Create a Healthy Workforce, a Vibrant Economy, and Thriving Communities

The third breakout group considered ways to engage the business community for the betterment of the public's health. Public health and business have many shared values: where communities are healthier, businesses thrive. In a healthy community, businesses benefit from healthier employees, higher retention rates, and easier recruitment. Likewise, many companies are interested in being good corporate citizens and may have data or data services that would be useful to public health officials.

Identifying Pockets of Success

Participants discussed the need to highlight examples of communities around the country that have fostered positive public/private collaboration. One attendee mentioned the Live Well San Diego initiative, which takes a holistic approach to community health—and recognizes the importance of economic health. However, for initiatives like this to succeed, they must be able to show the return on investment. CDC's 6 | 18 Initiative demonstrates this point. This initiative targets 6 common and costly health conditions—tobacco use, high blood pressure, healthcare-associated infections, asthma, unintended pregnancies, and diabetes—and 18 specific proven interventions that formed the starting point of discussions with healthcare purchasers, payers, and providers. It attempts to present a business case to Medicare/Medicaid and private payers when there are evidence-based interventions to alleviate high-cost, high-burden conditions.

Helping Businesses Help Public Health

The session also included a discussion of how to align a public health mission with business goals. One participant shared an example from Baton Rouge, Louisiana. Public health officials researched which companies were already investing in communities and leveraged that information for public health. By providing available health data, public health officials were able to paint a picture of the city the business was already investing in—and make recommendations on how their dollars could be strategically allocated to have the greatest impact. The group also emphasized the need to explore ways to operationalize and incentivize "data philanthropy"—a new form of partnership in which private sector companies share data for public benefit. It achieves similar goals to traditional philanthropy by allowing companies to give back in a way that produces meaningful impact and reflecting the businesses' core competencies while preserving or expanding value for shareholders.

Making Data Work for All

Participants discussed the use of data sharing for public/private collaboration. Businesses want a neutral source of health information, and public health can meet that need. In return, corporations might provide access to their own proprietary data or funding for initiatives and interventions. Past data-sharing efforts have been tremendously positive. For instance, a new public/private initiative in Snohomish County, WA, called Snohomish County Health & Well-Being Monitor combines 2-1-1 data and other sources of data to support community members' self-assessment and personal health goals. There may also be opportunities for setting up partnerships with universities; academic institutions can act as incubators for collaboration between science, business, and community.

Reflections and Next Steps

Connections with Other Public Health 3.0 Themes

While the meeting focused on **Data, Metrics, & Analytics**, achieving a Public Health 3.0–era informatics requires strong **Leadership & Workforce**, sufficient and smart **Funding**, cross-sectorial and shared value–driven **Partnerships**, and clearly defined **Foundational Capabilities & Infrastructure** support. Meeting participants highlighted the Public Health Accreditation Board as a key partner in renewing standards for accreditation and re-accreditation with PH3.0 in mind, e.g., developing measures on cross-sector collaborations by health departments, and better defining capabilities on data analysis and communication, policy formation and evaluation, and community engagement. Some challenges were noted for lower-resourced health departments to meet these standards, though other participants considered these criteria to be aspirational. Participants also discussed how to evolve the PH3.0 workforce, especially with professionals from other fields. For instance, in addition to schools of public health and medicine, individuals trained in economics, architecture, and urban planning could be encouraged to work in public health.

Next Steps: Questions to Consider for the 5 Public Health 3.0 Regional Meetings

As the roundtable aimed to inform dialogues related to data, metrics, and analytics in the upcoming listening sessions in Allegheny, PA; Santa Rosa, CA; Kansas City, MO; Nashville, TN; and Spokane, WA, participants suggested the following key discussion points:

- What are the current capabilities of the data systems used by public health in their regions, and what are their experiences with partnering outside of their immediate sector?
- What questions do local public health officials answer or seek answers to every day? What data or analytics tools are needed to help answer those questions?
- How do the healthcare and public health sectors prioritize among efforts to collect more data versus efforts to analyze and share the data that has already been collected?
- In terms of data linkage and aggregating, is there another regional entity that could be a neutral convener aside from public health departments, or a key partner?
- How can federal agencies support state and local health departments in moving toward PH3.0 data and analytics?

KEY RECOMMENDATIONS

The future of public health will require more innovative and timely use of data and analytics to understand the health of people and communities. The Public Health 3.0 model calls for a data infrastructure that is (1) timely and frequently updated, (2) sufficiently granular and locally relevant, with at least sub-county-level information, (3) comprehensive or linkable to social, economic, and environmental determinants of health data, and (4) accessible and actionable. To realize such vision, the following recommendations emerged from the roundtable discussions:

1. Invest in data linkage and visualization at all levels of governmental public health enterprise, and continue the federal progress on open data. This will require additional technical, human, and fiscal resources. For example, technical assistance and training may be needed on generating data-use agreements and data stewardship at the local level.
2. Create a national dashboard of metrics, relevant at the local level, that reports not only on individual level measures of health, but also on community health, including social determinants. Coordination will be necessary to bring together organizations, including the federal enterprise, to find agreement on a basic set of shared measures that can be the foundation for national and local efforts, while allowing room for customization to address local needs and priorities. Non-traditional metrics, such as civic engagement and walkability indices, should be explored for their utility in capturing communities' social determinants of health.
3. Explore the use of non-traditional data sources (such as administrative records, retail data, wearable technology, and social media) to provide a broader view of health and health behaviors than traditionally available to and used by public health. This will require building partnerships with other agencies within the government and with the private sector to assess the opportunities and limitations of these data sources and to perhaps build platforms to share use cases and streamline access and availability. Coordination is also needed among several ongoing efforts to aggregate and map public data.
4. Identify value in sharing resources in data and analytics for healthcare providers and public health agencies. With the expansion of electronic health records and regional health information exchanges, public health departments should develop and strengthen their capabilities to include information on healthcare encounters (admissions/discharges) in their foundational array of tools in understanding their communities' health needs.
5. There is a pressing need to invest in non-proprietary predictive analytics and mapping tools to make the data actionable at the local level without intense curation or manipulation.

6. While many surveillance, data collection, and aggregation activities may take place at the federal or state level, qualitative analyses to interpret and translate data should be done in partnership with local communities, including public/private partnerships with community-based organizations and with academic institutions.

7. Data privacy and security must remain of paramount importance. Many datasets concerning health, housing, and income data may have appropriate privacy protections that represent barriers to sharing or linking. Federal and local governments need to clearly articulate privacy standards and incorporate state-specific rules. Technical assistance and experience sharing regarding data-use agreements and data-sharing platforms are key.

Appendix 1: Meeting Agenda

Time	Session Topic
9–9:15AM	Welcome, introductions, and logistics
9:15–9:45AM	Setting the stage: How can an enhanced data, metrics, and analytics infrastructure fuel the transition into Public Health 3.0?
9:45–11:45AM	Information needs, data, and predictive analytics for Public Health 3.0: Where are we and where do we go from here?
	Panel 1: Voices from the field: Leveraging data and informatics infrastructure *What kinds of data and information do local public health leaders need to fully engage in cross-sector, PH3.0-style leadership, planning, and preventive interventions? How can we ensure that data is timely and sufficiently granular to guide resource allocation? What data, metrics, and analytics infrastructure (including training) needs to be developed and implemented to foster PH3.0 at the local health department level?*
	Panel 2: Frontiers in big data for public health *How can public health officials harness the power of big data in addition to electronic health records and surveys in order to: better understand what creates health for the community and why; foresee emerging health threats; and shape how public health agencies can respond to present and coming challenges to promote health equity?*
	Panel 3: Innovations in metrics and predictive modeling for PH3.0 decision making *How can we use metrics to set benchmarks and track progress? What are the roles for—and essential features of—predictive and systems-based models in informing public health leaders about the likely health consequences and relative benefits of interventions targeted at various social determinants of health? What cutting-edge tools exist now that could help move PH3.0 forward?*
12–1PM	Lunch on your own

1–2PM	Concurrent breakout sessions *How have data, metrics, and analytics tools and infrastructure been created and leveraged to support leaders in identifying the most vulnerable groups, prioritizing actions, and evaluating cost-benefit tradeoffs, and how may they be in the future?* **Group A.** Creating a healthy built environment and making healthy choices the easy choice **Group B.** Supporting the needs of vulnerable populations and promoting health equity **Group C.** Working with businesses to create a healthy workforce, a vibrant economy, and thriving communities
2–2:45PM	**Panel:** Reporting back from breakout groups
3–4PM	**Open discussion:** Reflections and next steps How can the roundtable inform regional and national meetings? What does the roadmap look like for building a PH3.0 data, metrics, and analytics infrastructure? How can the recommended transition strategies be seeded, scaled, and implemented? What are the optimal roles of federal public health practice and research enterprises?
4PM	Meeting adjourned

Appendix 2: List of Participants

Chris Aldridge, MSW

Senior Advisor, Public Health Programs, National Association of County & City Health Officials

Alina Baciu, MPH, PhD

Senior Program Officer, Institute of Medicine, National Academy of Sciences

Luis Belen

CEO, National Health IT Collaborative for the Underserved

Carter Blakey

Deputy Director, Office of Disease Prevention and Health Promotion, HHS

Jason Block, MD, MPH

Harvard Pilgrim Health Care Institute & Harvard Medical School

John Brownstein, PhD

Chief Innovation Officer, Boston Children's Hospital; Professor, Harvard Medical School

Derek Chapman, PhD

Associate Research Director, Virginia Commonwealth University Center on Society & Health

Teresa Clark, MBA, MPH

Vice President, Office of Clinical Affairs, BlueCross BlueShield Association

James Daniel, MPH

Public Health Coordinator, Office of the National Coordinator for Health IT, HHS

Karen DeSalvo, MD, MPH

Acting Assistant Secretary for Health & National Coordinator for Health Information Technology, HHS

Dustin Duncan, ScD

Assistant Professor, Department of Population Health at New York University School of Medicine
Director, Spatial Epidemiology Lab

Peter Eckart

Co-director, Data Across Sectors for Health at Illinois Public Health Institute

Tom Eckstein, MBA

Principal, Arundel Metrics, Inc.
Published America's Health Rankings reports

Abdul El-Sayed, MD, DPhil

Executive Director of Public Health & Health Officer, City of Detroit

Rebecca Freeman, PhD

Chief Nursing Officer, Office of the National Coordinator for Health Information Technology, HHS

Christopher Fulcher, PhD

Director, CARES Division of Applied Social Sciences, University of Missouri

Rayid Ghani, MS

Director, Center for Data Science & Public Policy, University of Chicago

Robin Ghertner, PhD

Director of Data & Technical Analysis, Office of Assistant Secretary for Planning and Evaluation, HHS

Wayne Giles, MD, MS

Director, Division of Population Health, CDC

Neal Halfon, MD, MPH

Director, UCLA Center for Healthier Children, Families & Communities

Rich Hamburg, MPA

Deputy Director, Trust for America's Health

Charles Homer, PhD

Deputy Assistant Secretary, Human Services Policy, ASPE/HHS

David Kendrick, MD, MPH

Principal Investigator & CEO, MyHealth Access Network

Joe Kiani, BSEE, MSEE

Founder, Chairman, & Chief Executive Officer, Masimo Corporation
Founder, Patient Safety Movement Foundation

Denise Koo, MD, MPH

Advisor to the Associate Director for Policy, Centers for Disease Control and Prevention

J. T. Lane, MPH

Principal, Health Management Associates

Cannon Leavelle

Advisor to the Assistant Secretary for Health, HHS

Jeff Levi, PhD

Professor, Milken Institute School of Public Health at The George Washington University

David McCallie, Jr., MD

Senior Vice President of Medical Informatics, Cerner Corporation

Ernest Moy, MD, MPH

Medical Officer, Agency for Healthcare Research and Quality

Rebecca Niles, MBA

Senior Facilitator of System Strategy, ReThink Health

Nancy Nurthen, MPH

Director of Division of Fusion, Office of the Assistant Secretary for Preparedness and Response, HHS

Patrick O'Carroll, MD, MPH

Rear Admiral, Assistant Surgeon General of U.S. Public Health Service
HHS Region X Health Administrator

Michael Painter, JD, MD

Senior Program Officer, Robert Wood Johnson Foundation

Elizabeth Walker Romero, MS

Senior Director of Health Improvements, Association of State and Territorial Health Officials

James Scanlon

Deputy Assistant Secretary for Planning and Evaluation, HHS

Joshua Sharfstein, MD

Associate Dean for Public Health Practice & Training, Johns Hopkins Bloomberg School of Public Health

Paula Soper, MPH, DrPH

Senior Director of Public Health Informatics, Association of State and Territorial Health Officials

Lee Stevens, PhD

Program Manager, Office of the National Coordinator for Health IT, HHS

David Sulek, MA

Principal Director, Booz Allen Hamilton

Bharat Sutariya, MD

Vice President & Chief Medical Officer, Cerner Corporation

Christopher Traver

Senior Advisor for Information Sharing, Administration for Children and Families, HHS

Y. Claire Wang, MD, ScD

RWJF Health Policy Fellow, Office of the Assistant Secretary for Health, HHS
Associate Professor, Columbia Mailman School of Public Health

Appendix 3: List of Resources

6 |18 Initiative, CDC

CDC is partnering with healthcare purchasers, payers, and providers to improve health and control cost. CDC provides these partners with rigorous evidence about high-burden health conditions and associated interventions to inform their decisions to have the greatest health and cost impact. www.cdc.gov/sixeighteen

500 Cities Project, CDC Foundation

In partnership with CDC and the Robert Wood Johnson Foundation, the CDC Foundation is releasing a first-of-its-kind data analysis for the 500 largest American cities, and the census tracts within cities, to identify, analyze, and report data for a select number of chronic disease measures. www.cdcfoundation.org/blog-entry/500-cities-project-local-data-better-health

America's Health Rankings, United Health Foundation

America's Health Rankings releases 2 annual reports that capture state health metrics: 1 on the health of the general population and 1 on the health of the senior population (people aged 65 and older). www.americashealthrankings.org

Community Commons, University of Missouri Center for Applied Research on Environmental Systems

Community Commons is a platform that overlays community-level data with national data. It provides public access to thousands of meaningful data layers that allow mapping and reporting capabilities with a goal for users to explore community health. www.communitycommons.org

County Health Rankings & Roadmaps, Robert Wood Johnson Foundation (RWJF)

County Health Rankings are based on a model of population health that emphasizes the many factors that, if improved, can help make communities healthier places to live, learn, work, and play. www.countyhealthrankings.org

Data.gov

Home of the U.S. Government's open data, this website hosts data, tools, and resources to conduct research, develop web and mobile applications, design data visualizations, and more. Under the terms of the 2013 Federal Open Data Policy, newly generated government data is required to be made available in open, machine-readable formats, while continuing to ensure privacy and security. www.data.gov

Data Across Sectors for Health, RWJF

Data Across Sectors for Health aims to identify barriers, opportunities, promising practices, and indicators of progress for multi-sector collaborations to connect information systems and share data for community health improvement. www.dashconnect.org

Healthy People

Healthy People provides science-based, 10-year national objectives for improving the health of all Americans. A smaller set of Healthy People 2020 objectives, called Leading Health Indicators, have been selected to communicate high-priority health issues and actions that can be taken to address them. DATA2020, the Healthy People 2020 interactive data tool, allows users to explore data and technical information related to the Healthy People 2020 objectives. www.healthypeople.gov

National Committee on Vital and Health Statistics (NCVHS)

Established in 1949, NCVHS is the statutory public advisory body to the Secretary of Health and Human Services on key health data issues related to community and population health, standards, privacy and confidentiality, quality, and data access and use. www.ncvhs.hhs.gov

Pew-MacArthur Results First Initiative, The Pew Charitable Trusts and the John D. and Catherine T. MacArthur Foundation

The Pew-MacArthur Results First Initiative works with states and localities to develop the tools policymakers need to identify and fund programs that yield high returns on investment. www.pewtrusts.org/en/research-and-analysis/fact-sheets/2015/07/the-pew-macarthur-results-first-initiative

ReThink Health Dynamics Model, ReThink Health, Fannie E. Rippel Foundation

The ReThink Health Dynamics Model is designed to help groups overcome the challenges of health system change, to better understand what is possible, and to develop targeted strategies to achieve lasting system-wide goals. www.rethinkhealth.org/resources-list/dynamic-modeling-strategy

Web-based Analysis and Visualization Environment (Weave), University of Massachusetts Lowell, Institute for Visualization and Perception Research

Weave is a new web-based visualization platform designed to enable visualization of any available data by anyone for any purpose. www.oicweave.org/index.php

FURTHER READINGS

i. Chetty R, Stepner M, Abraham S, Lin S, Scuderi B, Turner N, Bergeron A, Cutler D. The Association Between Income and Life Expectancy in the United States, 2001-2014. JAMA [Internet]. 2016;315(16):1750–1766. doi:10.1001/jama.2016.4226

ii. DeSalvo KB, O'Carroll PW, Koo D, Auerbach JM, Monroe JA. Public Health 3.0: Time for an Upgrade. American Journal of Public Health [Internet]. 2016;106(4):621–622. doi:10.2105/ajph.2016.303063

iii. The Institute of Medicine has since become the Health and Medicine Division of the National Academies of Sciences, Engineering, and Medicine.

iv. Institute of Medicine. The Future of Public Health. Washington, D.C.: The National Academies Press; 1988. Retrieved from: http://www.nationalacademies.org/hmd/Reports/1988/The-Future-of-Public-Health.aspx

v. HealthyPeople.gov [Internet]. Social Determinants of Health. Washington, D.C.: Office of Disease Prevention and Health Promotion, U.S. Department of Health and Human Services. No date. Retrieved from: https://www.healthypeople.gov/2020/topics-objectives/topic/social-determinants-of-health

vi. Institute of Medicine. For the Public's Health: Investing in a Healthier Future. Washington, D.C.: The National Academies Press; 2012. Retrieved from: http://www.nationalacademies.org/hmd/Reports/2012/For-the-Publics-Health-Investing-in-a-Healthier-Future.aspx

vii. Detroit Health Department.

viii. JASON: The MITRE Corporation. Data for Individual Health [Internet]. Rockville (MD): Agency for Healthcare Research and Quality; 2014 Nov. AHRQ Publication No. 15-0006-EF. Retrieved from: https://healthit.ahrq.gov/sites/default/files/docs/publication/2014-jason-data-for-individual-health.pdf

ix. Virginia Tech. Data for Health: Learning What Works [Internet]. Princeton (NJ): Robert Wood Johnson Foundation; 2015 Apr. Retrieved from: http://www.rwjf.org/content/dam/farm/reports/reports/2015/rwjf418628

x. Institute of Medicine. Vital Signs: Core Metrics for Health and Health Care Progress Report Brief. Washington, D.C.: The National Academies Press; 2015 Apr. Retrieved from: http://www.nationalacademies.org/hmd/~/media/Files/Report%20Files/2015/Vital_Signs/VitalSigns_RB.pdf

xi. National Committee on Vital and Health Statistics. Environmental Scan of Existing Domains and Indicators to Inform Development of a New Measurement Framework for Assessing the Health and Vitality of Communities. Retrieved from: http://www.ncvhs.hhs.gov/wp-content/uploads/2016/06/NCVHS-Indicators-Envirn-Scan_2016-06-01-FINAL.pdf

Office of the Assistant Secretary for Health
U.S. Department of Health and Human Services